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ABSTRACT

The experience described in this work was conducted in a discipline at Escola Politecnica in University of Sao Paulo. This discipline has a multidisciplinary character and almost all subjects discussed during engineering course might be addressed. Also, aspects related to aptitude and attitudes can be easily trained and discussed in this discipline. An institutional regulation for final grade of disciplines at Metallurgical and Materials Engineering Department (PMT) takes in account three tests and a seminar or experimental work. This institutional aspect was adapted in 1997 to approximately forty different kinds of evaluation including: group dynamics, video oriented activities, music oriented activities, experimental work and so on. This was a first trial to apply continuous evaluation at this discipline. The first two classes were very important to motivate students to participate of all proposed activities. An Aesop fable and requirements to be a good performance professional were discussed during these classes. Also, discipline program was presented and discussed at the beginning of the discipline. The introduction of these activities showed very good results. All the time students were predisposed to do activities and reports, when requested. Frequency in classes were more than 90%, indicating there were encouraged by new methodology. (Author)

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Innovations to Improve Teaching Quality at Escola Politécnica of USP: Experience at Metallurgical and Materials Engineering Department

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Abstract- *The experience described in this work was conducted in a discipline at Escola Politécnica in University of São Paulo. This discipline has a multidisciplinary character and almost all subjects discussed during engineering course might be addressed. Also, aspects related to aptitude and attitudes can be easily trained and discussed in this discipline.*

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Introduction

Motivation

This work was motivated by two facts. First, every semester take place previous semester disciplines evaluations by students at Metallurgical and Materials Engineering Department (PMT). My discipline presented not very good results according to students' opinion in 1995. In evaluation of my discipline, one student wrote 'terrorist but extremely accessible..". This result was a little strange. I thought on the reasons and I did not find anyone. I was a professor with very good intentions about students' formation. And that was all. At that time I had no formation about teaching methodology Thus, I had aspiration to know why students did not like the way I taught my discipline. Second, in 1996, directory of Escola Politécnica started a program to train professors interested in knowing more about didactic methodology for engineering disciplines. This was my chance. I took three different courses with Prof. Masseto and finally I understood why students did not like my course. I learned that most of engineering professors are engineers by profession and adapted their classes methodology based on previous experiences, when they attended to undergraduate and graduate courses. I also realized that knowledge of didactic techniques are important to optimize teaching efficiency. I was a professor with good teaching intentions and no theory about how to use it with students. So, I decided to change my didactic methodology to improve teaching quality in my discipline.

Characteristics of this engineering discipline

The discipline is entitled "Metallurgy and Welding Processes", taught in 9th semester of Metallurgical Engineering Course in 1997, for approximately 25 students and with four 50 minutes classes per week. The course is focused in welding and joining processes and in metallurgical changes during welding which might change performance of a component. With these approaches it is easy to give a multidisciplinary course in the sense of relating previous disciplines in Metallurgical Engineering Course with this one.

Class Activities

The first two classes

I put all efforts in the first two classes of my discipline. I had two tasks: change the relationship between students and professor and motivate students. In the first class I started with a crossed-introduction, where two students interview each other and at the end one student introduces the other to the class, which can ask questions. Each year the professor is the person they ask more questions. This activity reached its objective of warm up class for the second activity. The duration of this activity was approximately 30 min.

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I introduced second activity as a story I everyday read to my girls (4 and 7 years old) during bed time. This fable is an Aesop's fable, named "The hares and the foxes".

The Hares and the Foxes

"THE HARES waged war with the Eagles, and called upon the Foxes to help them. They replied, "We would willingly have helped you, if we had not to know who you were, and with whom you were fighting"

Moral of story: Count the cost before you commit yourselves.

(http://www.pacific.net/Aesop's Fables)

This fable has a very special moral of story where people have to learn how to work in group, but to reach the goal they have to have same objectives. After reading the fable, It was proposed an activity to correlate the moral of history with formation of engineers and the engineering course. Some of results were: formation with professionalism, professional ethic aspects, responsibility, working in group, environmental aspects of profession, respect to customer, and a very amazing result (it happened the three times I used this activity): "students are the rabbits, professors are the foxes and the school is the eagles". At the end of di scussion, that lasted 15 min, I was comfortable to start a discussion about the difference between teaching and learning, professor/students relationships and professional approach in my course, with a professional professor and professional students working together.

After this activity, I started a new one emphasizing the aspects of abilities and skills with students might develop during course and in their job. Table 1 presents these aspects.

Table 1 - Abilities and skills for students.

At University	At work
• reading	• managing time
• writing	• optimizing costs
• oral expression	• work in group
• hearing	• teaching other
• learning	• acquiring and
• creativity	• communicating
• solving problems	• working with new
• deciding and	• working with
• responsibility	
• self-esteem	
• integrity	
• sociability	

With these in mind I explained the objectives we would work together during the course. After this debate I gave them a preliminary program to discuss and include their expectations about the focus of the discipline. One important aspect discussed was evaluation. This time I proposed intead of a "non-three-tests+seminar" kind of evaluation, a kind of continuous evaluation. In practice it was proposed to replace the usual way to calculate the final grade by approximately 44 different kinds of evaluations. The students agreed with the proposal. In this part of the activity students knew the objective of professor behavior during previous courses and also time-consuming activities.

A video activity

A video entitled "Welding, brazing and cutting using oxy-acetylene flames" with duration of 15 min was used for a directed study. In this activity the students received a sheet with 10 questions related to the subject of the film. They read the questions, watched the film and answered the questions. At the end they corrected the answers watching once again the film. Finally, I asked them about doubts related to the subject and also stressed important aspects of the subject. This activity was a result of at least three trials in different years and modifications were based upon students' feedback about the easiest way to learn these subjects. I tested different combinations to obtain the best

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result: without reading before video, reading before and interrupting the video and explaining relevant parts and reading, watching, answering, and correcting relevant aspects of this subject. The last one gave best results in the sense of reaching the objectives of this part of the program. Results of this methodology were: grouping three classes in one and receiving the subject by an audio-visual type of communication media. This kind of media is important to present important sounds to avoid future problems with handling equipment.

Three group activities

Observation-verbalization activity.

This activity was used in class together with a writing one-page-synthesis, prepared at home, of three different welding process with a common characteristic for developing the activity. All students wrote a one-page synthesis of each one. Four volunteers started to speak up about the common part of the subject while four groups of four students noticing specific parts of the behavior and speech of the four-talking-students. They observed and take notes about group organization (time, sequence, who take notes, ...) and important theoretical, economical, and environmental issues of welding processes. At the end, each observing group exposed their impressions about the observed aspect. Professor concluded the activity correcting wrong concepts and presenting aspects not addressed during class discussion. Results of this activity were clearly a lack of training in work in group, managing a group meeting and how to approach the subject. The verbalization group did not organize themselves regarding time, sequence and taking notes. Also, the students did not approach cost, quality and productivity during discussion. Theoretical aspects were correctly presented. At this time students were not secure about working by themselves. Students enjoyed this integrated activity and, in their opinion, "it is a very good activity for learning and organizing the important topics of this part of the program" and "the synthesis were very important in this process".

Verbalization group

Questions proposed: Welding process with shielding gas protection.

Observation groups

Group 1.

Task: Observe group organization (all students have a change to speak up about the proposed subject, they organize themselves, who take notes of discussed aspects, they need to speak loud to class, they used all time for present aspects related to subject)

Group 2.

Task: Observe if theoretical concepts will be used during presentation; Are they correlation new concepts with concepts discussed in other classes? Are they given practical application during presentation?

Group 3.

Task: Aspects related to cost, quality and productivity were addressed?

Group 4.

Task: the group stressed aspects related to different materials; welder skill; welding out-of-position.

Opposing groups.

This activity started in a similar manner with the previous one. After preparing at home an one-page-synthesis about two welding process class were divided in four equal groups. Two groups worked with one specific process. The two groups had different functions: one provided arguments about advantages of the welding process (they were not admitted to speak up) and the other only presented and defended the arguments to the opposite group (they were not allowed to give new arguments). The components of the groups were not admitted to change functions by themselves. For this it was utilized three cards with different color. One, the green, was a card for all students. When I showed this color they changed groups and subjects. The yellow one had a function of changing groups within same subject. The blue card was used to replace two students from one group to another one. The subjects for discussion were presented in four gradual kind of approach. That means, further subject add a relevant detail to produce a more in depth discussion. After presenting a new proposed question, students were allowed to discuss inside groups to have arguments for about 1 minute. This activity lasted about 40 minutes. In the beginning students were prone to do activity but it was hard to start. At the end it was difficult to finish this activity. One student comment "this activity is important to discuss aspects of discipline in a non-linear approach. We had to think about different aspects at the same time. This is important to keep important aspects of discussed subject".

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Opposing groups:

Subject for discussion: Advantages of welding processes with slag
(First big group: Covered electrode; Second big group: Submerged arc)

Proposed questions:

1) Welding of metallic materials.
2) Welding of carbon steels with 15 mm thick.
3) Welding of carbon steels with 15 mm thick out-of-position.
4) Welding of carbon steels with 15 mm thick out-of-position for a kind of industry with high productivity.

Integrated panel.
This is a large group activity, were class is divided in about five groups, each one with a part of a general subject. After this activity one student of each group went to a new group were a question is proposed. In this case, question is related to a knowledge unit and with a general approach, such as "You learned about different processes, what are the requirements to choose a specific one?". This group a ctivity was really important to wrap up this knowledge unit. This activity was important for me to control how familiar students were with this one-month of activity. Students liked integrated panel and, again, I had difficulty of finishing this activity. One student comment "this activity was important for me because I understood how hard is to work with people with different way of thinking about same subject". In my opinion students had an opportuni ty to train how to hear other people. In the first part of activity students grouped in same-affinity-groups but in second group students were randomly distributed and these affinity groups were dissolved in second part.

Integrated panel

First part: 5 groups of 5 students

Subjects for each group: Correlate with all welding processes studied

1) kind of joint , bevel and plate thickness.
2) welding position and welder skill.
3) kind of metallic material to be welded.
5) quality of welded joint.
1) cost productivity and automation.

Second part: 5 groups of 5 students

How to choose a welding process?

A conventional test with different kind of correction
At the end of one knowledge unity a conventional test were given. It consisted of a multiple choice test with fifteen questions and 4 written questions. Tests were correct by professor with no marks or comments in each test but in a separate peace of paper with my grades. In next class I distributed test for different students to correct by themselves the test. I gave them the criteria and a suggested answer. They corrected the test and gave grades. We discussed all questions during correction. Results are presented in table 2.

Based on these results students presented a tendency to correct test, an activity they like too much, with same criteria using a self-evaluation component. Except one student gave a higher grade for him (I made a mi stake when summing the value of each question). This activity was important for them because they a feedback about test in next class. Also, doubts were discussed during correction.

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Table 2 - Comparison of student and professor grades about same test.

Student	1st part (multiple choice)	2nd part (writing questions)		Test grade
		Professor	Student	
Bill	4.0	2.5	2.25	6.5
Bill	.4	4.25	NP	6.7
Bill	1.6	1.75	NP	3.4
Bill	2.25	2.25	2.75	4.8
Bill	2.4	1.0	0.0	3.4
Bill	2.0	1.75	1.0	3.8
Bill	3.2	0.75	1.5	4.0
Mary	2.4	3.0	3.0	5.4
Bill	2.4	4.35	NP	6.5
Mary	2.0	4.5	2.75	6.5
Bill	2.8	3.25	3.0	6.1
Bill	1.6	1.0	1.25	2.6
Bill	2.0	3.8	2.75	5.8
Bill	1.2	0.75	0.5	1.7
Bill	2.4	2.75	2.75	5.2
Bill	1.6	1.75	NP	3.4
Bill	1.2	0.25	0.25	1.5

Obs.: Underlined notes in column 3 were selected to compose test grade.

An experimental work

An experimental work for a group in this discipline is not easy. There are serious problems with student security in lab, therefore they need to know how to behave in the lab during experiment. To overcome this problem they started with a video oriented activity about security in a welding lab. This activity was similar to one discussed previously in this paper. Before class, at home, students were motivated to read a chapter about costs in welding. After that, in the lab, a group of six students welded a plate of steel. They need to take notes about parameters important for determining welding costs. With these collected data they had material enough to prepare a first report related to welding costs. With welded sample the group did other two reports. During experiment welding thermal cycles were recorded. This material was used for second report about heat transfer in welding. Elaboration of this report was simultaneous with theoretical classes about this subject. Third report was a correlation between thermal cycles and microstructural changes in the material that changes material performance. With these three reports students were able to correlate costs with performance of a welded material. There is a plan for a fourth activity to work with aspects of welding quality to complete the objective of this activity.

A musical activity

This was an end-course activity with small groups (2 students). I played a music ("Money" performed by Pink Floyd) as a motivation to discuss, based upon lyrics and rhythm, engineering course, engineering profession and my discipline. This discussion had a background music ("Us and them" performed by Pink Floyd) that served also as a control of time for discussion. For my surprise all students did this activity with a high level of concentration. Subject of discussion was based on lyrics. In this focus, professional ethics versus money was discussed, environmental issues were addressed and "fun" is as important as money. On ly one group made a correlation between rhythm and the proposed questions. One student remained quiet during all activity. After class I asked him about his behavior. He answered he could not think with a subjective motivation and correlate with an objective task. I explained the objective of this activity was to present a different way to work. And we need to improve ourselves. At the end music was played as a last message ("Eclipse" performed by Pink Floyd).

Final Comments

At the end a final evaluation of the course was made. One significant result, according to students, was group activities. This was the most important activity to learn a subject. They kept interested in this discipline due to a previous preparation of all classes and interest present by professor during activities. Interest increased with different group activities and subjects studied. Finally, they felt more confident to speak in public and more critic and better observer.

I believe the modification in my discipline since1996 is in the right direction. With 44 evaluations, some of them

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described in this paper, I feel more comfortable to evaluate students' performance, together with them. Maybe I made a lot of mistakes with my experiences, but the results I had kept me going in a direction to improve learning and relationship between professors and students.

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